Overnight home oximetry: can it identify patients with obstructive sleep apnea–hypopnea who have minimal daytime sleepiness?

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Abstract *Background*: Overnight home oximetry is being widely used as a case selection technique for patients with suspected obstructive sleep apnea–hypopnea (OSAH). In the absence of excessive daytime sleepiness (EDS), patients with snoring and/or witnessed apnea are considered to have low probability of OSAH. *Methods*: Patients suspected to have OSAH, who denied EDS, and had a normal overnight home oximetry were studied by polysomnography for presence of significant OSAH (apnea/hypopnea index (AHI) > 15/h). *Results*: Twelve (40%) of the 30 patients studied had significant OSAH. All had a 2% oxygen desaturation index of less than 10/h. The sensitivity of oximetry increased at lower desaturation indices but this was associated with decreased specificity. Review of oximetry waveform pattern, by experienced physicians, did not improve the diagnostic accuracy. Combining oximetry with a clinical prediction rule would have reduced the need for polysomnography by 30%. *Conclusion*: Many patients, who present with snoring and/or witnessed apnea and are referred to a sleep disorder clinic for suspected OSAH, may have significant OSAH even if they deny EDS. Overnight home oximetry did not help discriminate between those patients with or without OSAH.

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Keywords obstructive sleep apnea-hypopnea; excessive daytime sleepiness; case selection; oximetry.

INTRODUCTION

Increased recognition of obstructive sleep apnea–hypopnea (OSAH) in the community has led to a rapid rise in the number of patients being seen by family physicians and subsequently being referred to sleep disorder clinics for further evaluation. Patients with suspected OSAH can be categorized based on severity of symptoms to facilitate decision-making with regard to the use of diagnostic tests and the assignment for probability of disease. Patients with snoring and witnessed apnea in the absence of excessive daytime sleepiness (EDS) are generally thought to have a low probability of OSAH.

Recognition of OSAH based on history and clinical examination alone has a low predictive value (1). The current gold standard for the diagnosis of OSAH is an overnight polysomnography. In view of its convenience and low cost, overnight home oximetry has been widely used as a case selection technique to identify patients in need of polysomnography. The predominant symptom of OSAH is EDS and the Epworth Sleepiness Scale (ESS) is a widely used validated assessment of EDS (2). Overnight home oximetry and ESS are simple tools, which a family physician could utilize to case select patients for referral for polysomnography.

The objective of this study was to evaluate patients referred to a sleep disorder clinic with a suspicion of OSAH (based on history of loud snoring and/or witnessed apnea) who denied EDS based on an ESS score of <10 and had normal overnight home oximetry. The aim of the study was to evaluate these patients for presence of OSAH defined as an apnea-hypopnea index (AHI) of >15/h.

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METHODS

Subjects

Unselected patients referred to a tertiary sleep disorder clinic for investigation of suspected OSAH over a 7-month period, with ESS score <10 were eligible for

inclusion in the study. Each patient had a detailed history and physical examination. Patients were determined to have hypertension if they were on anti-hypertensive medication or were found to have a blood pressure above 150/90 mmHg on examination. Patients were determined to have depression if they were on antidepressant medication or were under physician care for depression. Overnight home oximetry was performed within a week of initial consultation. The first 30 patients with a normal overnight home oximetry (defined as 2% oxygen desaturation index of less than 10/h) were recruited to this prospective study. All of the patients had an overnight polysomnography performed within 4 weeks of overnight home oximetry.

Home oximetry

Home oximetry was performed using a pulse oximeter (Ohmeda 3740, Louisville, CO). It stores the lowest arterial oxygen saturation (SaO_2) over the preceding 12-s period for a total of 8-h period. The stored data were digitally transferred to a microcomputer (PC IBM Boca Raton, FL, USA) and analyzed for 2, 3 and 4% oxygen desaturation. Four respiratory physicians, with an interest in sleep-disordered breathing, were asked to interpret the waveform data as normal (OSAH unlikely), abnormal (OSAH likely), or indeterminate.

Diagnostic polysomnography

Overnight polysomnography was conducted and scored according to the previously described method (3). The variables monitored were electroencephalogram (EEG), electrooculogram (EOG), chin and leg electromyogram (EMG), electrocardiogram (ECG), oronasal airflow (CO_2 analyzer), oxygen saturation, and chest and abdominal wall movements (respiratory inductive plethysmograph). All of these studies were manually scored for sleep stage, apnea type, and duration. Obstructive apneas were defined as the cessation of airflow for at least 10 s accompanied by ongoing respiratory effort. Central apneas were defined as the cessation of airflow and respiratory effort for at least 10 s. Mixed apneas were defined as a combination of an obstructive and central apnea lasting for at least 10 s. Hypopneas were defined as a decrease of more than 50% in thoracoabdominal amplitude or clear reduction in thoracoabdominal amplitude less than 50% associated with a 3% desaturation or an arousal for at least 10 s. Arousal was defined as the simultaneous presence of EMG activation, eye movements and alpha activity. Oxygen desaturation was defined as 3% drop in arterial oxygen saturation followed by a 2% resaturation. The severity of OSAH was assessed in terms of the apnea–hypopnea index (AHI).

Results are presented as mean (range) unless stated otherwise. Bivariate analysis was performed for comparison between groups of patients with and without OSAH. All P values <0.05 were considered significant. For overnight oximetry, the number of true-positive (a), false-positive (b), false-negative (c) and true-negative (d) were determined. Sensitivity (a/a+c), specificity (d/b+d), positive predictive value (a/a+b), negative predictive value (d/c+d) and accuracy (a+d/a+b+c+d) were then calculated.

RESULTS

Table 1 summarizes the characteristics of patients studied. All the patients had awake $SaO_2 > 96\%$. Polysomnography results confirmed that 12(40%) patients had AHI >15/h, and six of these had an AHI $\geq$ 30/h. The mean (range) AHI was 28 (16–62) with an arousal index of 22 (9–47) per h. No patient had any other sleep disorder such as periodic limb movement disorder. The patients with OSAH were predominantly male (83%) with increased neck circumference but had a similar age distribution, body mass index, mean nocturnal SaO_2 and ESS, compared to the group without significant OSAH (Table 2)

Accuracy of overnight home oximetry and waveform inspection

All the patients had a 2% oxygen desaturation index (ODI-2%) of less than 10/h and were considered not to have significant OSAH prior to the polysomnography. The 2% desaturation index at an index of 6/h had a sensitivity of 33%, specificity of 88% and a negative predictive value of 67%. The sensitivity of overnight home oximetry increased at lower desaturation indices but this resulted

Table 1. Characteristics of the study population (total=30)

Personal data	Mean (Range)
Age (years)	45.2 (21–63)
Body mass index (kg/m^2)	31.5 (21–51)
Neck size (cm)	39.8 (33–50)
Epworth Sleepiness Scale score	6.2 (1–9)
Symptoms	**Present (%)**
Loud snoring	97
Witnessed apnea	80
Unrefreshing sleep	77
Frequent nocturnal awakening	60
Depression	13
High blood pressure	13

Table 2. Characteristics of patients with and without significant OSAH

	AHI > 15	AHI < 15	
Total No.	12	18	
M:F	10:2	5:13	
	Mean (SD)	Mean (SD)	P-value
Age (years)	46.0 (13.2)	44.7 (11.8)	NS
Weight (kg)	107.0 (27.1)	80.4 (20.5)	0.02
Height (cm)	174.5 (6.4)	168.7 (9.9)	NS
Body mass index (kg/m^2)	35.2 (9.2)	29.1 (7.8)	NS
Neck size (cm)	42.7 (4.1)	37.9 (4.0)	0.007
Epworth Sleepiness Scale score	5.2 (2.6)	6.8 (2.5)	NS
Mean SaO_2 (%)	96.0 (1.2)	96.3 (1.0)	NS

Table 3. Accuracy of overnight oximetry and clinical prediction rule in the diagnosis of OSAH

	Clinical prediction rule	ODI-2% 6/h	ODI-3% 4/h	ODI-4% 2/h
Sensitivity (%)	87	33	25	33
Specificity (%)	50	88	88	88
Positive predictive value (%)	66	66	60	66
Negative predictive value (%)	77	66	64	66
Accuracy (%)	70	67	63	67

ODI=desaturation index.

in decreased specificity (Table 3). There was considerable inter-observer disagreement on interpretation of waveform pattern. In only 23% of patients was there complete agreement on interpretation of the waveform pattern. Waveform inspection did not result in an improvement in the diagnostic accuracy of OSAH.

Use of the clinical prediction rule, described by Flemons, (4) gave a higher sensitivity (87%) but lower specificity (50%), than overnight home oximetry in the diagnosis of OSAH. Use of this clinical prediction rule, in our study population, would have identified 30% cases to be at a low risk of OSAH and so potentially would have reduced the need for polysomnography by 30%.

DISCUSSION

This study has shown that, up to 40% patients, who present to a sleep disorder clinic with snoring and witnessed apnea but deny EDS and have normal overnight home oximetry have significant OSAH. If overnight home oximetry alone were used as a case selection technique, then a large proportion of these patients would be misdiagnosed as not having OSAH. Although our results are from a selected patient population, they are consistent with the results of previous oximetry studies that reported a low sensitivity (31–72%) but a high specificity (74–100%) in the diagnosis of OSAH (5–7). Review of the oximetry waveform data did not lead to an improvement in the diagnostic accuracy of OSAH, as has been reported previously (8).

There is no universally accepted definition of either oxygen desaturation or an abnormal ODI in sleep-disordered breathing. A fall in oxyhemoglobin saturation of 2% or greater, if the rate of descent was $>0.1\%/s$ but $<4\%/s$, was evaluated in 10 polysomnography records containing nearly 2000 respiratory events. The sensitivity and specificity, respectively were 73.6 and 90.8% for detection of apnea, and 84.1 and were 86.1% for hypopnea (9). The 4% desaturation criteria has been used by many studies. Estimation of $>4\%$ desaturations were found to correlate best with changes in sleepiness score after therapy for 6 months (10). Studies have reported SaO_2 decreases of 2, 3 and 4% from baseline. Similarly, the threshold for an abnormal ODI has been defined as ≥ 5 desaturation/h (ODI-5), >10/h (ODI-10) and >15/h (ODI-15), but there is little evidence that one definition has a greater validity than the others (11). The specificity of oximetry as a diagnostic tool for OSAH increases at higher desaturation indices, but at the cost of decreased sensitivity. The diagnostic accuracy of $>4\%$ oxygen desaturation, at ODI-5, ODI-10 and ODI-15, has been reported to be 0.81, 0.75 and 0.70, respectively (12).

Epworth Sleepiness Scale is a simple questionnaire, which asks about the likelihood of falling asleep in eight different situations. It only requires a pen and paper, so can be used by a family physician to determine whether a patient has subjective excessive daytime sleepiness. Its main limitation is that it is self-administered and relies on the patient's ability to comprehend the questions and to answer them honestly. Clinical prediction rules have been developed to estimate the probability of OSAH and have been shown to reduce the need for polysomnography (4,13). However, they are scales that are more complex than Epworth Sleepiness Scale and are unlikely to be performed by family physicians.

Whether a patient has EDS or not is almost always based on subjective assessment. Objective tests such as multiple sleep latency test are only performed on selected patients and in limited centers because of their cost and expertise. Self-assessment of daytime symptoms may vary from one patient to another and the Epworth Sleepiness Scale may not reflect objective measures of sleepiness or OSAH severity (14). Whether patients with OSAH who snore but do not suffer from

EDS should be treated is controversial (15). Men with snoring and no EDS do not appear to carry an increased risk of mortality, compared to men with no snoring or EDS [16]. However patients with mild OSAH (AHI 5-15/h) have an improvement in ESS score, cognitive function and quality of life with CPAP therapy (17).

An interesting observation in our study was that 50% of our patients were women, which is an unusual distribution of patients referred for suspected OSAH. Furthermore, 83% of patients with AHI >15 were men whereas 72% of patients with AHI <15 were women. OSAH without EDS may be commoner in women than previous reports suggest (18). Gender differences had been noted in the clinical features of OSAH with women more likely to have difficulty initiating sleep, morning fatigue and morning headache, and less likely to report restless sleep or to have reported nocturnal apnea (19). Furthermore women are more likely to have a lower AHI and have more respiratory events during REM sleep than men (20). Gender differences in overnight home oximetry and clinical prediction rules have not been formally evaluated in patients with OSAH.

Potential limitations of our study include the relatively small sample of patients and the need to validate in a larger population. Secondly it was performed on a subgroup of patients with OSAH without EDS and as such the results cannot be generalized to all patients with suspected OSAH. The reason for selecting this subgroup was that these patients are generally not investigated further after a negative overnight home oximetry and consequently can be misled into believing they do not have significant OSAH.

In conclusion, 40% of patients referred to a specialty clinic with loud snoring or witnessed apnea and no EDS may have significant OSAH. The combination of Epworth Sleepiness Scale and overnight home oximetry as case selection techniques was unable to discriminate between those patients with or without OSAH. In patients with loud snoring or witnessed apnea and no EDS overnight home oximetry alone cannot be recommended to exclude significant OSAH. A clinical prediction rule may be more helpful but is unlikely to be performed by family physicians. The results of our study need to be validated in a family practice setting.

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